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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Provides a method for determining the directional dependence characteristics of direct reading dosimeters. The dosimeter is oriented in various positions and angles with reference to a calibrated radiation source, thus providing data for evaluating the directional accuracy.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-105 29 February 1980
Test Operations Procedure 6-2-561
AD No. A086440

DOSIMETER DIRECTIONAL DEPENDENCE, RADIAC

1. SCOPE.

The objective of this test operations procedure (TOP) is to standardize methods for performing directional sensitivity tests on direct reading type radiac dosimeters.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities. A physically secure enclosure or building which pro vides attenuation of all ionizing radiation to less than 2 millirad per hour at its outer walls or established perimeter.

2.2 Instrumentation (suggested)

	Accuracy
Secondary Standards (e.g., X-ray, AN/UDM-1, AN/UDM-1A J.L.S. MDL 138)	Corrected to 3% with source calibration correction factors applied.
Radiation Measuring Devices (RMD) (e.g., condenser "R" meter Victoreen Model 555 Radocon II)	±2% of full scale reading (RDG)
Barometer	±0.25 mm (100th inch) Hg
Thermometer °C	±1/2°C
Warning Device (Visual/Audio)	Sensitive to 2 mR/H
Photodosimetry Film Badge	±10%
Pocket Dosimeter (0-200 mR)	±10%

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Item	Accuracy
Radiacmeter, PDR-27 or equivalent	±10%
Timer, hours	±10 seconds
Timer, minutes	±1 second
Dosimeter Holding Accessories	Alignment and tilt within ±1°

3. PREPARATION FOR TEST.

3.1 Facilities. Inspect facilities for conformance to minimum requirements and that all safety alarms and controls are operating.

3.2 Test Equipment. Select a radiation source that will provide the energy level specified by the instructions applicable to the dosimeter under test. Source calibration data must be traceable to the National Bureau of Standards (NBS).

3.2.1 Determine the time periods of exposure for each dosimeter and each source. This information may be tabulated in test plan.

3.3 Personnel. Insure that all test personnel are familiar with the required technical and operational characteristics of the dosimeter under test. The operational and safety requirements applicable to the radioactive source being used shall be the subject of a thorough briefing before start of test as specified by 10 CFR Part 19.12, .13 and 20.1.

3.4 Instrumentation. Set up and check all instrumentation in accordance with technical manuals, technical bulletins or manufacturers' specifications applicable to the radiation source used and the dosimeter under test. Confirm that the calibrations are current. Set up and position the radiation measur ing devices in the same location as the detecting element of the dosimeter being tested.

3.4.1 Select radiation measuring devices (RMD) ideally having an accuracy of at least one order of magnitude greater than that afforded by the dosimeter being tested. The RMD shall have current calibrations traceable to the National Bureau of Standards (NBS).

3.5 Data Required. Record the following:

3.5.1 Test Item. Type, Model No., Serial No., Nomenclature and Manufacturer name as applicable. Include manufacturer's stated characteristics in the report as an annex.

3.5.2 Instrumentation. Type, Model, Serial Number, Nomenclature, Manufacturer, and calibration due date.

3.5.3 Test Data Records. See paragraph 5 below.

4. TEST CONTROLS.

4.1 Radiation measuring devices will be set up inside the secure **area.**

4.2 Thoroughly inspect the dosimeter under test for obvious physical and optical defects. Record and photograph any defects observed.

4.2.1 All defects will be noted and recorded before proceeding with the test.

5. PERFORMANCE TEST.

Several dosimeters may be tested simultaneously. The time period of radiation exposure will be determined in the test plan for a specific make and model.

5.1 Test Preparation. Determine the proper distance between the selected radiation source and the dosimeter under test from the radiation source calibration tables and positioning chart necessary to expose the dosimeter to obtain a midscale reading.

a. The detailed test plan for a specific dosimeter will specify the allowable percent of deviation at midscale.

b. Express the distance in meters and the time of exposure in hours and fractions of an hour (i.e., 5.33 hours or 5-1/3 hours).

c. Temperature is recorded in °C.

d. Barometric pressure is recorded in millimeters (mm) of mercury (Hg).

5.1.1 Place the dosimeter holding block (see fig. 1) on the test table at the distance from the source as determined in paragraph 5.1 above.

5.1.2 Place the dosimeter under test in the holding block (see fig. 1) and the radiation measuring device (RMD) on the test table positioned and oriented as shown in figure 1A to obtain the baseline reading. Establish a reference orientation, i.e., clip away from source.

5.1.3 Repeat the exposures with the dosimeter rotated about its longitudinal axis with the clip faced towards the source, or at 90° left and right to determine radial symmetry.

5.2 Data to be recorded during the test.

a. Radiation source used.

b. Radiation exposure time.

c. RMD reading for each radiation source.

d. Ambient temperature each day for standard temperature/pressure (STP) correction.

e. Barometric pressure each day for STP correction.

f. Any correction factors used.

g. Dose readings of dosimeter under test.

h. Tilt angles and/or position of dosimeter under test referenced to source.

5.3 Isotropism.

NOTE: The following may be used with figures 1a, b, and c and data blocks 1 through 5..

5.3.1 Set the dosimeter under test to zero.

5.3.2 Place the dosimeter under test and the RMD in the holding block mounted on the test table as shown in figure 1A.

5.3.3 Open the radiation source to radiate the dosimeter under test and RMD for the predetermined time period, then close.

5.3.4 Repeat paragraphs 5.3.1 through 5.3.3 as needed for baseline data required in paragraph 5.1, record on data sheet (Appendix B).

5.3.5 Reposition the dosimeter under test in the holding block to the forward angle position as shown in figure 1B (several angles may be tested).

5.3.6 Repeat paragraph 5.3.3 and record data on data sheet (Appendix B).

5.3.7 Reposition the dosimeter under test in the holding block to the aft angle position as shown in figure 1B.

5.3.8 Repeat paragraph 5.3.3 and record data on data sheet.

5.3.9 Place a reference mark on dosimeter for horizontal rotation.

5.3.10 Position the dosimeter under test in the holding block in the horizontal position as shown in figure 1C.

5.3.11 Repeat paragraph 5.3.3 and record data on the data sheet.

5.3.12 Rotate the dosimeter under test on their horizontal axis 90 degrees.

5.3.13 Repeat paragraph 5.3.3 and record data.

5.3.14 Repeat paragraph 5.3.12 and 5.3.13 for each 90 degrees through 360 degrees rotation.

5.4 Geotropism.

NOTE: The following may be used with figure 10 and data block 6.

5.4.1 Set the dosimeter under test to zero.

5.4.2 Position the dosimeter under test in the horizontal plane so that zero is at the left.

5.4.3 Record the reading of the dosimeter under test.

5.4.4 Rotate the dosimeter under test 90 degrees on the horizontal axis so that zero is at the top.

5.4.5 Repeat paragraph 5.4.3.

5.4.6 Rotate the dosimeter under test to 180 degrees on the horizontal axis so that zero is at the bottom.

5.4.7 Repeat paragraph 5.4.3.

5.4.8 Rotate the dosimeter under test to 270 degrees on the horizontal axis so that zero is at the right.

5.4.9 Repeat paragraph 5.4.3.

5.4.10 Set the dosimeter under test to midscale and repeat paragraphs 5.4.2 through 5.4.9.

5.4.11 Set the dosimeter under test to fullscale and repeat paragraphs 5.4.2 through 5.4.9.

5.4.12 Position the dosimeter under test in the vertical plane, scale up (reference Appendix B, Figure 2, Position 2).

5.4.13 Repeat paragraph 5.4.3

5.4.14 Position the dosimeter under test in the vertical plane, scale down (reference Appendix B, Figure 2, Position 3).

5.4.15 Repeat paragraph 5.4.3.

6. DATA REDUCTION AND PRESENTATION.

6.1 The data should be presented in tabular and/or graphical form (as shown in Appendix B) showing dosimeter readings versus radiation measuring device readings.

6.2 The percent difference limits should be shown to allow direct comparison of values against a criteria.

6.3 The criteria should define the percent difference limits.

6.4 The RMD data may require correction for temperature and barometric pressure* for each day's data or as needed using the following:

Temperature-Pressure Correction Factor

$$CF = \frac{760\ (273 + T)}{295 \times P}$$

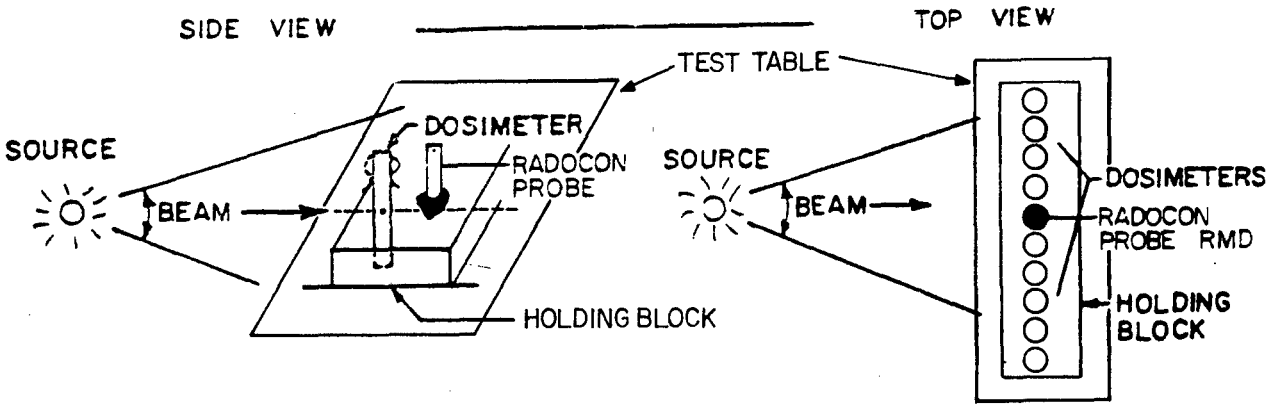
T = Degrees Celsius (C°), P = Millimeters of Mercury (mmHg)

*Certain radiation measuring devices (particularly free air ionization chambers) require correction factors. Consult manufacturer's specifications if in doubt.

6.5 Additional observed data regarding the test item should be included to facilitate analysis.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, Maryland 21005. Technical information may be obtained from the preparing activity: Commander, US Army Electronic Proving Ground, ATTN: STEEP-MT-T, Fort Huachuca, Arizona 85613. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No.) printed on the first page.

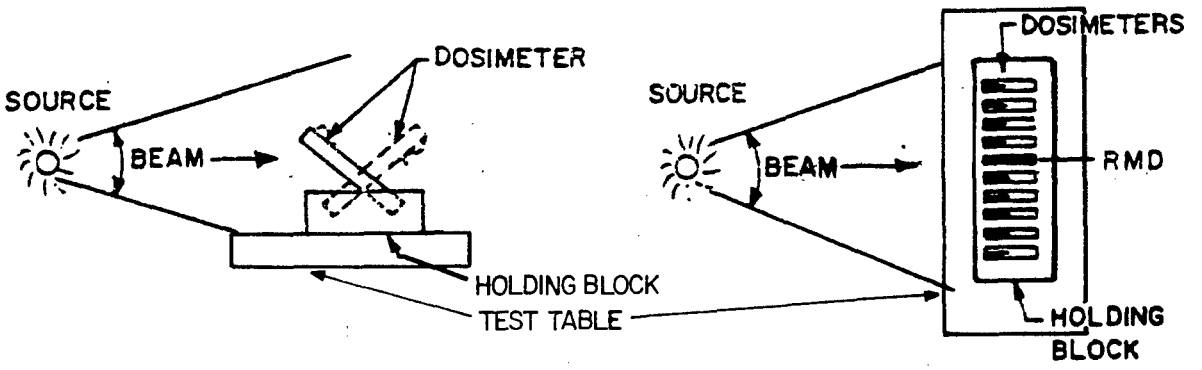
DOSIMETER DIRECTIONAL DEPENDENCE



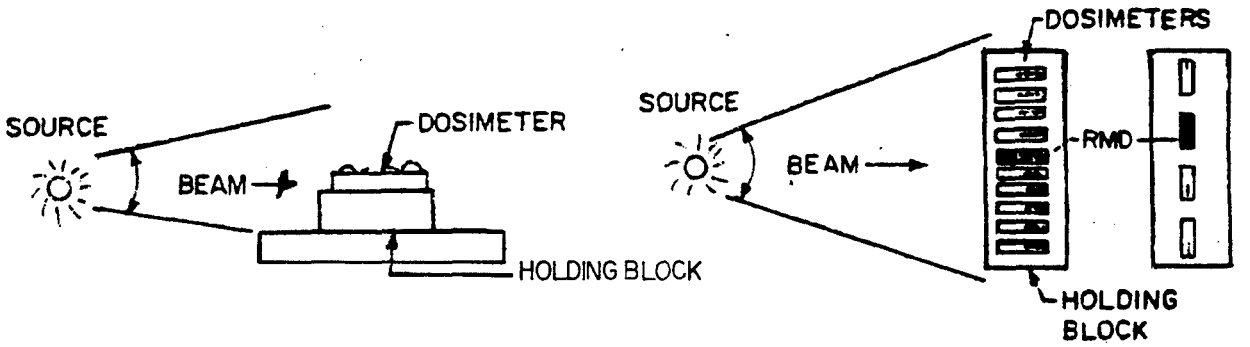
A - BASELINE DETERMINATION (RMD) ISOTROPISM, VERTICAL, 90°

NOTE: THE CLIP IS SHOWN SOLID FOR THE DRAWN POSITION AND DOTTED FOR THE ALTERNATE POSITION.

RADIATION MEASUREMENT DEVICE (RMD)



B - ISOTROPISM TILT ANGLES REFERENCED TO SOURCE



C - ISOTROPISM DEGREE OF ROTATION HORIZONTAL, 0, 90, 180, 270

Figure 1A, 1B, and 1C.

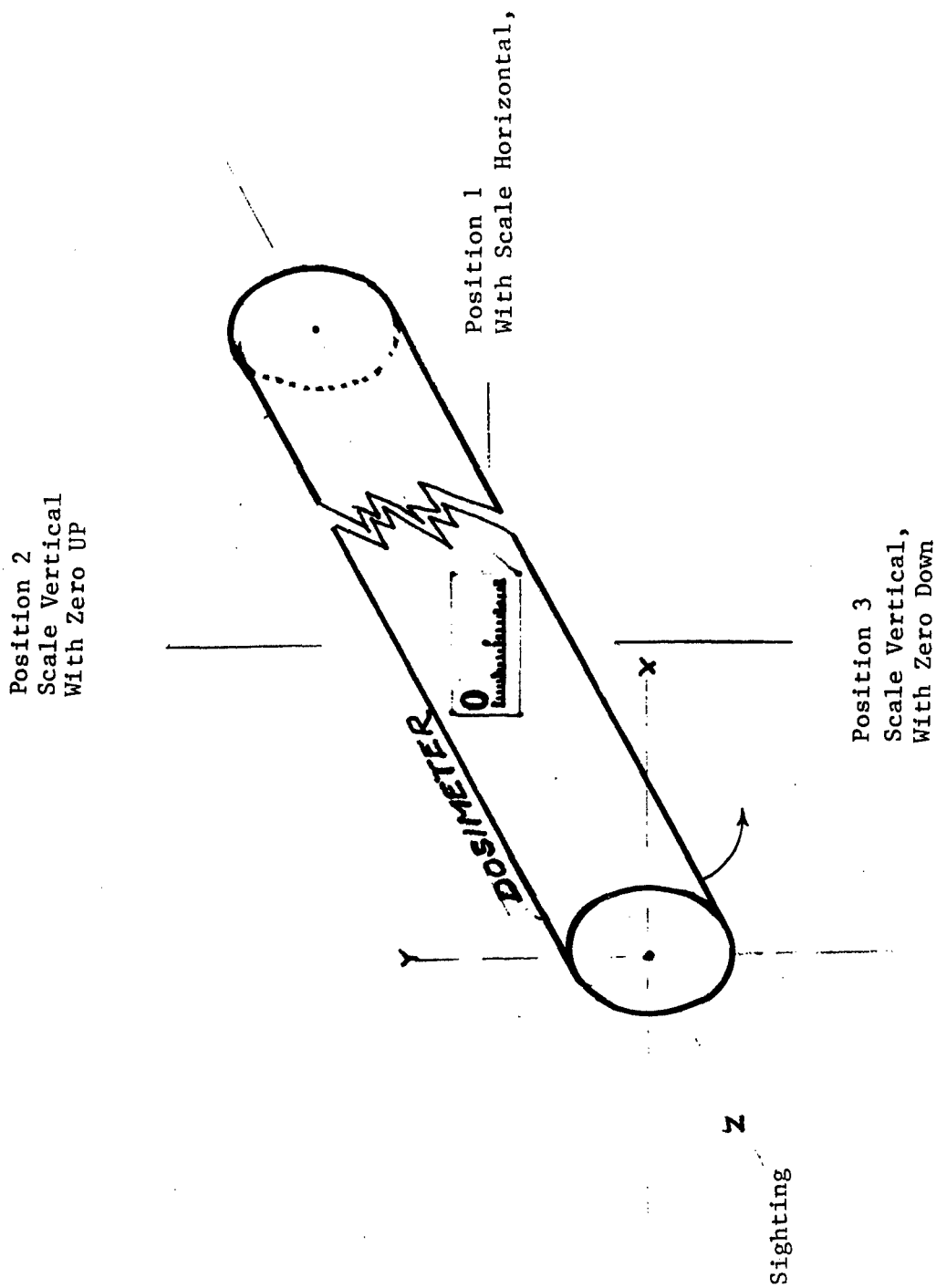


Figure 1D. Geotropism gravitational effects.

APPENDIX A.

CHECKLIST

DIRECTIONAL DEPENDENCE

Facility conforms to requirments. _____

Instrumentation calibration due date. _____

Name, Grade, and MOS/Series of persons conducting test recorded. _____

Test item data recorded. _____

Instrumentation data recorded. _____

Physical security for both the operating personnel and unauthorized arrivals confirmed. _____

Personnel indoctrinated in safety requirements, alarms, etc. _____

Test data recorded. _____

Data reduced. _____

Each item to be initialed by the person in charge.

APPENDIX B.

DOSIMETER DIRECTIONAL DEPENDENCE

Pretest Data

1. Dosimeter Serial Nos. _____

Mod No. _____ Type _____ Nomenclature _____ Mfr _____

2. Instrumentation Radiation Source _____

	Type/Mod. No.	Serial No.	Mfr	Cal Due Date	Nomenclature

3. Pretest Checks 4. BaseLine Barometric Pressure - mmHg

Optics _____ a. Exposure Time _____ b. Exposure Time _____ c. Exposure Time _____

Indicator Reading _____ RMD Reading _____ RMD Reading _____ RMD Reading _____

Mechanical _____ Dosimeter Reading ____ Dosimeter Reading ____ Dosimeter Reading ____

Temp, C° _____ Temp, C° _____ Temp, C° _____

DOSIMETER DIRECTIONAL DEPENDENCE (cont)

5. Directional Data. See figures 1A, 1B, and 1C.

Dosimeter, S/N _____

__° tilt test item toward source

Data RMD _____ Test Item _____

__° tilt test item away from source

RMD _____ Test Item _____

__° tilt test item toward source

Data RMD _____ Test Item _____

__° tilt test item away from source

RMD _____ Test Item _____

Horizontal - Toward Source

RMD _____ Test Item _____

Horizontal - Away from Source

RMD _____ Test Item _____

Vertical - Toward Source

RMD _____ Test Item _____

Vertical - Away from Source

RMD _____ Test Item _____

The clip or other reference point of the dosimeter test item.

Dosimeter, S/N _____

__° tilt toward source

RMD _____ Test Item _____

__° tilt away from source

RMD _____ Test Item _____

__° tilt toward source

RMD _____ Test Item _____

__° tilt away from source

RMD _____ Test Item _____

Horizontal - Toward Source

RMD _____ Test Item _____

Horizontal - Away from Source

RMD _____ Test Item _____

Vertical - Toward Source

RMD _____ Test Item _____

Vertical - Away from Source

RMD _____ Test Item _____

Note: The degree of tilt angle and the number of tilt angle data points should be determined in the final test plan.

6. GEOTROPISM DATA

Set dosimeter at zero.

Horizontal, zero at left _____
Horizontal, zero at top _____
Horizontal, zero at bottom _____
Horizontal, zero at right _____

Set dosimeter at midscale.

Horizontal, zero at left _____
Horizontal, zero at top _____
Horizontal, zero at bottom _____
Horizontal, zero at right _____

Set dosimeter at zero.

Vertical, zero at left _____
Vertical, zero at top _____
Vertical, zero at bottom _____
Vertical, zero at right _____

Set dosimeter at midscale.

Vertical, zero at left _____
Vertical, zero at top _____
Vertical, zero at bottom _____
Vertical, zero at right _____